CLAIMS

1. An engine controller comprising an exhaust purifying device capable of purifying NOx at an air-fuel ratio richer than stoichiometry, wherein a first combustion region, a second combustion region, and a third combustion region are defined as combustion regions having air-fuel ratios of the mixture gas feeding combustion that sequentially vary from rich to lean, wherein combustion regions are switched from the first combustion region to the third combustion region via the second combustion region, or from the third combustion region to the first combustion region via the second combustion region, the engine controller further comprising:

a combustion control means for controlling the mass of intake air introduced into the combustion chamber upon switching of combustion regions in a manner different from when normal, so as to minimize the mass of NOx emission downstream of the exhaust purifying device and the torque variation when the second combustion region is passed.

2. An engine controller comprising an exhaust purifying device capable of purifying NOx at an air-fuel ratio richer than stoichiometry, wherein a first combustion region, a second combustion region, and a third combustion region are defined as combustion regions having air-fuel ratios of the mixture gas feeding combustion that sequentially vary from rich to lean, wherein combustion regions are switched from the first combustion region to the third combustion region via the second combustion region, or from the third combustion region to the third combustion region via the second combustion region, the engine controller further comprising:

means for estimating the mass of NOx emission downstream of the exhaust purifying device online upon passing of the second combustion region;

means for estimating torque variation online upon passing of the second

combustion region; and

combustion control means for reducing the mass of NOx emission downstream of the exhaust purifying device and the torque variation below predetermined values based on the estimated value of the mass of NOx emission and the estimated value of the torque variation when the second combustion region is passed.

3. The controller according to claim 2, wherein the means for estimating the mass of NOx emission comprises:

means for estimating the mass of NOx emission at the entrance to the exhaust purifying device when the second combustion region is passed based on the air-fuel ratio of the mixture gas feeding combustion, engine r.p.m., engine torque, and the mass of EGR introduced into the combustion chamber or the mass of EGR remaining in the combustion chamber; and

a catalyst model for estimating the mass of NOx emission at the exit of the exhaust purifying device based on the air-fuel ratio at the entrance to the exhaust purifying device, the temperature of the exhaust purifying device, and the estimated mass of NOx emission at the entrance to the exhaust purifying device.

4. The controller according to claim 2, wherein the means for estimating the mass of NOx emission estimates the mass of NOx emission downstream of the exhaust purifying device upon switching of combustion regions by accumulating the mass of NOx emission calculated at intervals of T2 for a period T1 that is required for the switching of combustion regions, where T2 is sufficiently shorter than T1.

5. The controller according to claim 2, further comprising an air-fuel ratio sensor for detecting the concentration of NOx in the exhaust gas upstream or downstream of the exhaust purifying device, wherein the means for estimating the mass of NOx emission adjusts parameters for the estimation of the mass of NOx emission

based on the output of the air-fuel ratio sensor.

6. The controller according to claim 2, wherein the means for estimating the torque variation estimates the torque variation based on the mass of fuel supply and the engine r.p.m. at the time of the passing of the second combustion region.

7. The controller according to claim 2, wherein the means for estimating the torque variation causes the intake air mass to be changed by changing the opening angle of the throttle valve within a predetermined time upon switching of combustion regions, and then estimates the torque variation based on an amount of torque variation due to a correction of the mass of fuel supply that is made so as to compensate the time delay in the change of the intake air mass in response to the change in the throttle valve.

8. The controller according to claim 7, wherein the means for estimating the torque variation causes the ignition timing to be retarded upon switching of combustion regions and then estimates the torque variation based on a value obtained by subtracting an amount of torque variation due to the retarding of the ignition timing from an amount of torque variation due to the correction of the mass of fuel supply.

9. The controller according to claim 2, further comprising a torque sensor for detecting the engine torque, wherein the means for estimating the torque variation adjusts parameters for the estimation of torque variation based on the output of the torque sensor.

10. The controller according to claim 2, further comprising means capable of varying the intake air mass in a shorter time than the time delay of the change in the intake air mass in response to the change in the opening angle of the throttle

valve, wherein the combustion control means causes the intake air mass to be changed using the means for varying the mass of air if the torque variation due to the correction of the fuel supply mass exceeds a predetermined value.

11. The controller according to claim 10, wherein the means for varying the mass of air comprises an intake valve of which at least one of the open/close time, the open/close timing, and the amount of lift is variable.

12. The controller according to claim 10, wherein the combustion control means corrects the fuel supply mass such that the air-fuel ratio of the mixture gas feeding combustion is changed within a predetermined time if the response delay in the air-fuel ratio of the mixture gas feeding combustion in response to a change in a target air-fuel ratio during the passing of the second combustion region exceeds a predetermined value.

13. The controller according to claim 12, wherein, if a torque variation is caused by the correction of the fuel supply mass during the passing of the second combustion region, the combustion control means suppresses the torque variation by retarding the ignition timing.

14. The controller according to claim 2, further comprising:

an exhaust system model for estimating the air-fuel ratio at the entrance to the exhaust purifying device based on the air-fuel ratio of the mixture gas, engine r.p.m., and engine torque during the passing of the second combustion region; and

an exhaust system inverse model for estimating the air-fuel ratio of the mixture gas based on the air-fuel ratio at the entrance to the exhaust purifying device that is estimated by the exhaust system model,

wherein the combustion control means changes the air-fuel ratio of the mixture gas based on the exhaust system inverse model if the time it takes to pass

the second combustion region exceeds a predetermined value.

15. The controller according to claim 14, wherein parameters of the exhaust system inverse model are adjusted based on the output of the air-fuel ratio sensor.

16. The controller according to claim 10, wherein the combustion control means, upon switching of combustion regions, adjusts the opening angle of the throttle valve so as to change the response characteristics of the air mass between the throttle valve and the means for varying the mass of air, and it simultaneously adjusts the operation of the means for varying the mass of air so as to make the intake air mass equal to that prior to the adjustment of the throttle valve opening angle, the combustion control means thereafter controlling the operation of the means for varying the mass of air so as to change the intake air mass.

17. The controller according to claim 2, wherein the first combustion region is defined as an air-fuel ratio region richer than stoichiometry.

18. The controller according to claim 2, wherein the exhaust purifying device comprises a lean NOx catalyst.

19. The controller according to claim 18, wherein the second combustion region is defined as an air-fuel ratio region between stoichiometry and an air-fuel ratio at which the NOx storage efficiency of the lean NOx catalyst exceeds a predetermined value.

20. The controller according to claim 18, wherein the third combustion region is defined as a region in which the air-fuel ratio is leaner than the air-fuel ratio at which the NOx storage efficiency of the lean NOx catalyst exceeds a predetermined value.

21. The controller according to claim 2, wherein the engine comprises a compression ignition engine and the exhaust purifying device comprises a three-way catalyst.

22. The controller according to claim 21, wherein the second combustion region is defined as an air-fuel ratio region between stoichiometry and an air-fuel ratio at which the NOx concentration at the exit of the combustion chamber drops below a predetermined value.

23. The controller according to claim 21, wherein the third combustion region is defined as a region in which the air-fuel ratio is leaner than the air-fuel ratio at which the NOx concentration at the exit of the combustion chamber is below a predetermined value.

24. An automobile in which an engine is mounted, to which the controller according to claim 2 is applied.